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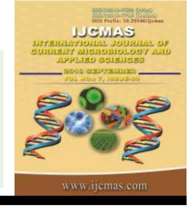

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Assessment of Nutrient Deficiencies Based on Response of Rice (*Oryza sativa* L.) to Nutrient Omission in *Inceptisols* of Kondagaon District of Chhattisgarh in India

Balwant Kumar[1], G.K. Sharma[1*], V.N. Mishra[2], A. Pradhan[1] and T. Chandrakar[1]

[1]*Shaheed Gundadhur College of Agriculture and Research Station, Jagdalpur - 494 005 (Chhattisgarh), India*
[2]*Department of Soil Science and Agricultural Chemistry, College of Agriculture, Raipur - 492 012 (Chhattisgarh), India*

**Corresponding author*

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A B S T R A C T

The investigation was carried out at Shaheed Gundadhur College of Agriculture and Research Station, Jagdalpur with the objectives to identify the specific yield limiting nutrients through response of rice to nutrient omission in pot culture during *kharif* season, 2017 and to demonstrate the optimum use of identified limiting nutrients at field level in wheat crop during *rabi* season 2017-18. The soil was a sandy clay loam, had a slightly acidic soil reaction (pH 6.2), normal electrical conductivity, medium organic C and available K, low available N, P, and S, high available Ca, Mg, Fe, Mn and Cu and marginal available Zn and B. The experiment was laid out under completely randomized design with 3 replications and 11 treatments, formulated by keeping one treatment with application of all nutrients in optimum level and others by sequentially omitting each nutrient. Omission of N and P nutrients significantly reduced the different growth, yield and nutrients uptake parameters of rice in comparison to all nutrients. The maximum grain yield of 67.1 g pot^{-1} was recorded, in all nutrients pot and 40.8 % reduction in grain yield of rice, from the maximum yield, was recorded in N omitted pots, followed by 23.7 % reduction in P omitted pots and omission of other nutrients didn't reduce the grain yield significantly indicating that only N and P were yield limiting nutrients. In field verification during *rabi* season, 17.8 % increase in wheat grain yield and 20.9 % increase in net return was recorded, due to optimum dose of identified yield limiting nutrients over farmer's practice dose.

Introduction

Adequate supply of plant nutrients decides optimum productivity of any cropping system. Even if, all other factors of crop production are in the optimum, the fertility of a soil largely determines the ultimate yield (Sekhon and Velayutham, 2002). When the soil does not supply sufficient nutrients for normal plant development and optimum productivity, application of supplemental nutrients is required. Fertilizer is one of the most important sources to meet this requirement. Indiscriminate use of fertilizers, however, may cause adverse effect on soils and crops both regarding nutrient toxicity and deficiency either by over use or inadequate use (Ray *et al.,* 2000). Soil fertility evaluation, thus, is the key factor for adequate and balanced fertilization of crops in high crop production systems. Soil and plant analyses are commonly performed to assess the fertility status of a soil with other diagnostic techniques including identification of deficiency symptoms and biological tests which are helpful in determining specific nutrient stresses and quantity of nutrients needed to optimize the yield (Havlin *et al.*, 2007). However, the analytical results do not indicate the most limiting nutrient according to Liebig's law of the minimum “the minimum nutrient is the factor that governs and controls growth and potential yield of crop”.

A nutrients omission trial aims to find out the most limiting nutrients to the growth of a crop plant. If any element is omitted while other elements are applied at suitable rates and plants grow weakly, then the tested element is a limiting factor for crop growth. Conversely, if any element is omitted but plants are healthy, then that element is not a limiting factor for crop production. Conducting fertilizer field trials is an expensive task and time consuming process. This information can be generated through pot culture trial in controlled conditions through laboratory and greenhouses studies. This situation calls to identify the yield limiting nutrients for correcting the deficiencies and boosting the crop yield.

Rice (*Oryza sativa*), is an important staple food of India and continues to play a vital role in the national food and livelihood security system. India is having largest area under rice crop. However, productivity is lower than world’s average productivity. The reason for low productivity is that rice is being grown in the country under various agro-ecologies in both irrigated and rainfed systems. States like Uttar Pradesh, Bihar, West Bengal, Orissa, Jharkhand, Chhattisgarh and Assam are having huge potential for rice cultivation and there is scope to increase productivity in this region.

The deficiency of some micro and secondary nutrients is one of the major causes for stagnation in crop productivity. Exploitive nature of modern agriculture involving use of high analysis NPK fertilizers, free from micronutrients as impurities, limited use of organic manures and restricted recycling of crop residues are some important factors having contributed towards accelerated exhaustion of secondary and micronutrients from soil. At several places, normal yield of crops could not be achieved despite balanced use of NPK due to micronutrient deficiency in soils (Sakal, 2001).

Chhattisgarh State has four major soils type *i.e. Entisols*, *Inceptisols*, *Alfisols* and *Vertisols*. Almost all soils are deficient in nitrogen and phosphorus and medium to high in potassium. Zinc deficiency is also reported in some patches of *Alfisols* and *Vertisols* of this region. In view of continuous use of sulfur free complex fertilizers, chances of increase in S deficiency are likely. In addition to this limitation, low fertilizer efficiency, inadequacy of current fertilizer recommendations and the ignorance of nutrients other than N, P, and K may limit crop production. In view of continuous use of high analysis fertilizer, multiple nutrient deficiencies are likely. High crop yields can only be achieved by correcting such deficiencies. Site specific nutrient management is of utmost importance for obtaining high yields on sustainable basis (Sahu *et al.,* 2017). However, little is known about the sustainability of the current production systems, particularly systems with multiple cropping under minimum practice.

Looking to very limited information on the proper and site specific nutrient doses to maximize yield of rice, present investigation was undertaken with the objective to assess the yield limiting nutrients based on rice response to nutrient omission and to demonstrate the optimum use of identified limiting nutrients and its comparison with farmer's fertilizer practice.

Materials and Methods

Location of the study

Apot culture investigation was undertaken with the objectives to identify the specific yield limiting nutrients through response of rice (MTU-1001) to nutrient omission in *Inceptisols* of *Kondagaon* district, during the kharif season 2017 at the green house of Section of Soil Science and Agricultural Chemistry,Shaheed Gundadhoor College of Agriculture and Research Station, Jagdalpur, Bastar (Chhattisgarh) and subsequently a demonstration at farmers field at village – Badebendri, block and district – Kondagaon to demonstrate the optimum use of identified limiting nutrients in wheat (GW-273) during *rabi* season 2017-18.The study site lies at $19^{0}10'$ N latitude and $81^{0}95$ E longitude with an altitude of 550-760 meter above the mean sea level.

Initial characteristics of the experimental soils

The *Inceptisols*, locally called *Matasi*, are immature soil with poor soil profile features having lighter texture and shallow to moderate depth. Soils are being used exclusive for growing early rice after bunding, puddling and leveling and for pulses and maize without bunding. They are soft and non-sticky when wet, easily workable under wet cultivation for puddling and *biasi* operation and therefore, can easily be managed to improve surface water retention for rice cultivation. Under this order the dominating sub-group is typic *haplustept* and Vertic *haplustept*. *Vertic haplustept* have clayey texture with clay content varying from 48.0 to 55.0%. Typic *haplustept* is sandy clay loam to clay loam in texture with clay content raining from to 33.2 to 50.4%. The initial physicochemical characteristics of the experimental soil (*Inceptisol*) were determined (Table 1) using common field and laboratory procedures. The experimental soil was a sandy clay loam, had a slightly acidic soil reaction (pH 6.2), normal electrical conductivity, medium organic C and available K, low available N, P, and S, high available Ca, Mg, Fe, Mn and Cu and marginal available Zn and B (Table 1).

Experimental plan

The experiment was laid out under completely randomized design with 3 replications and 11 treatments, formulated by keeping one treatment with application of all nutrients in optimum level and others by sequentially omitting each nutrient. Bulk soil samples representative of *Inceptisols* of the district was collected from the farmer's fields for pot culture experiment. The processed and uniformed soil samples were filled in plastic pots @ 20 kg and nutrients as specified above were applied through different sources taking care to avoid any precipitation during solution mixing and application. The optimum doses of nutrients were fixed in kg ha^{-1} as N -150, P_2O_5 - 100, K_2O - 100, S - 45, Ca - 110, Mg - 50, Fe - 20, Mn - 7.5, Cu - 7.5, Zn -7.5, B - 3 and Mo - 0.75 for SSNM dose. Rice (MTU-1001) was taken as test crop. The pots were maintained saturation with standing water and twenty five days old seedlings of rice (MTU-1001) were transplanted on 22^{th} July 2017. Three seedlings of MTU-1001 variety of rice were planted in three hills in each pot and water level was maintained at 3 cm throughout the crop season. Thereafter, full dose of all the nutrients except nitrogen was added to the soil in solution form. Nitrogen as urea was applied in three splits at transplanting, tillering and panicle initiation stage. Crop was grown till maturity and harvested on 17th November, 2017. The effects of treatments were recorded in terms of yield, different yield attributing parameters and nutrient uptake by rice crop. Based on these results, N and P nutrients were identified as yield limiting nutrients. The optimum use of limiting nutrients was demonstrated at farmer's field, from where the bulk soil was collected, with wheat variety GW-273 as a test crop during *rabi* season 2017-18.The wheat crop was sown on 14th Dec 2017 and harvested on 14th April 2018. The farmer's used fertilizer dose at the rate of 80 kgN: 50kgP_2O_5: 30 kg K_2O ha^{-1}. The effects of optimum/SSNM dose was compared with farmer's fertilizer practice.

Results and Discussion

Growth and yield attributes of rice

Plant height

Omission of nutrients had a significant effect on plant height of rice crop (Table 2). Plant height is one of the most important characteristics which indicate nutrients absorption capacity as well as health of the soil and plant. The highest plant height of rice was recorded under treatment where all the nutrients were supplied, whereas significantly lower plant height was recorded under the treatments missing N, and P nutrients.

Number of tillers pot^{-1}

Significantly higher number of tillers pot^{-1}, recorded at 60 days after transplanting of rice, was observed in treatment that received all nutrients and on the other hand, omission of N and P nutrients significantly reduced the number of tillers pot^{-1}in comparison to all nutrients (Table 2). Omission of other nutrients didn't reduce the number of tillers pot^{-1} significantly. N plays a key role in tillers bearing of rice followed by P. On an average, 21.3 tillers pot^{-1}was observed, at 60 DAT, with treatment that received all nutrients and various nutrients omission treatments had reduced number of tillers. Omission of N and P reduced the number of tillers significantly as these two nutrients have major role in tillers bearing of the crop. Many researchers have also concluded the importance of N and P in tillering of rice (Singh, 2008, Sahu *et al.*, 2017).

Number of effective tillers pot^{-1}

Omission of N and P nutrients significantly reduced the effective tillerspot^{-1}of rice as compared to treatment that received all nutrients. Other nutrients omission didn't reduce the effective tillers pot^{-1} of rice.

Number of filled grains panicle^{-1}

Similar trend was also observed for number of filled grains per panicle of rice which varied from 112.3 to 142.0. The treatments missing N and P nutrients recorded significantly reduced number of filled grains per panicle as compared to treatment which received all nutrients (Table 2).

Test weight

A close examination of the data pertaining to test weight (1000 grain weight) presented in Table 2 showed that the test weight of rice grain didn't varied significantly with different treatments. In general, the test weight of rice grain varied from 25.2 to 26.0g per1000 grains.However, omission of N and P pots had reduced the test weight as compared to those of all other treatments. It is universally truth that N and P are the most important major nutrients require for tillering, root growth and general plant vigor that affect ultimately filled grains and test weight. The reduced effective tillers, number of filled grains per panicle and test weight were recorded in present study because of omission of N and P nutrients.

Since N is an important constituent of amino acids, proteins and protoplast, its application had a more pronounced effect on plant growth and development through better utilization of photo-synthates and more vegetative growth. These results are in conformity of the findings of Singh, (2008) and Sharma *et al.,* (2000). P omission had also exhibited a significant effect on plant height. Optimum P availability is essential for normal growth and development and the utilization of other nutrients, particularly N. The significant crop response to P application was also reported by many workers (Ahmed *et al.,* 2010 and Mc Beath *et al.*, 2007).

Yield of rice

Grain yield

The maximum grain yield (67.1 g pot^{-1}) was recorded under the treatment receiving all the nutrients and that of the lowest grain yields (39.7 g pot^{-1}) was recorded under omission of N followed by omission of P (51.2 g pot^{-1}) nutrients. Omission of N and P nutrients significantly reduced the grain yield of rice in comparison to the treatment that received all nutrients. In other treatments, grain yields were observed statistically at par in comparison to treatment where all the nutrients were supplied to rice crop (Table 2).

Grain yield reduction

The reduction of rice grain yield because of omission of different plant nutrients, from treatment that received all nutrients, wasalso worked out (Table 2). The yield limiting nutrients which reduced the yield by about 10% from the maximum yield obtained by treatment receiving all nutrients, was critically observed. It was noticed that omission of N reduced the grain yield of rice by 40.8 % and P omission caused a reduction of 23.7 % in grain yield of rice. Large reductions in the grain yield of rice were observed with the omission of N and P as compared to the other nutrient omission treatments. The yield reductions were more pronounced with N omission. Result clearly indicates that N is the most critical nutrients that affect the grain yield considerably followed by P. Omission of all other nutrients did not indicate yield reduction.

Straw yield

It is evident from the data in Table 2 that the mean straw yields of rice were significantly affected with imposition of different nutrient omission treatments. Omission of N and P significantly reduced the straw yield as compared to treatment where all the nutrients were supplied. The highest straw yield (83.0 g pot^{-1}) of rice was observed in treatment that omit Ca which was at par with treatment where all the nutrients were applied and lowest (50.8 pot^{-1}) in treatment where N was omitted followed by P omission treatment.

Primary nutrient uptake

N uptake

The data in Table 3 indicated that the nitrogen uptake by rice was significantly affected with application of different missing nutrient treatments. Omission of N and P significantly reduced the N uptake by rice as compared to treatment where all the nutrients were supplied. The highest N uptake of 1.12 g pot^{-1} was recorded in the treatment that received all the nutrients and that of the lowest N uptake of 0.65 g pot^{-1} was recorded in the pots where N was omitted. Supply of all the nutrients including nitrogen in "All" treatment increased the grain and straw yields as well as the nitrogen concentrations causing more uptake of N (Syed *et al.*, 2006). Minimum nitrogen uptake was observed with nitrogen omission because nitrogen was the most yield limiting nutrient which resulted in lower yields and lower nitrogen uptake. The similar findings were also reported by Mishra *et al.*, (2007).

Phosphorus uptake

The highest total uptake of P by rice was recorded to the tune of 0.26 g pot^{-1} under the treatment where all the nutrients were applied. Whereas the lowest total P uptake (0.15g pot^{-1}) was observed in the treatment that missed N. Reductions in P uptake with omission of N and P have also been reported by Mishra *et al.*, (2007) for rice crop and similar reductions in P concentration with omission of P have also been reported by Din *et al.*, (2001) for chickpea. Supply of P in "All" treatment increased the soil solution P causing higher absorption of P resulting in higher grain and straw yields as well more uptake of P because P was the next most yield limiting nutrient after N, which resulted in lower yields and lower P concentrations.

Potassium uptake

The highest K uptake (1.37 g pot^{-1}) was observed in the treatment that received all the nutrients and Ca omitted pots and the lowest K uptake (0.83 g pot^{-1}) were registered in the N omission treatment followed by P omission treatment. Omission of N and P nutrients significantly reduced the K uptake by rice in comparison to treatment that received all nutrients.

Table.1 Initial physicochemical characteristics of experimental soils

S. No.	Soil Characteristics	Value	Rating
1.	**Mechanical Analysis**		
	Sand (%)	55	Sandy clay loam
	Silt (%)	24	
	Clay (%)	21	
2.	**pH (1:2.5 soil: water suspension)**	6.2	Slightly acidic
3.	**Electrical Conductivity (dS m^{-1})**	0.14	Normal
4.	**Organic C (%)**	0.55	Medium
5.	**N Available (kg ha^{-1})**	247	Low
6.	**P Available (kg ha^{-1})**	10.0	Low
7.	**K Available (kg ha^{-1})**	158	Medium
8.	**S Available (kg ha^{-1})**	18.4	Low
9.	**Ca Available (kg ha^{-1})**	1040	High
10.	**Mg Available (kg ha^{-1})**	496	High
11.	**Fe Available (mg kg^{-1})**	60.36	High
12.	**Mn Available (mg kg^{-1})**	21.91	High
13.	**Zn Available (mg kg^{-1})**	0.97	Marginal
14.	**Cu Available (mg kg^{-1})**	1.14	High
15.	**B Available (mg kg^{-1})**	0.53	Marginal

Table.2 Effect of nutrient omission on yield and yield attributes of rice (MTU-1001) in *Inceptisol* of *Kondagaon* district of Chhattisgarh

Treatments	Plant height (cm)	Tillers (No. pot^{-1})	Effective tillers (No. pot^{-1})	Filled grains (No. panicle^{-1})	Test weight (g 1000 grains^{-1})	Grain yield (g pot^{-1})	Grain yield reduction (%)	Straw yield (g pot^{-1})
All	99.6	21.3	18.3	142.0	26.0	67.1	-	82.5
All-N	85.4	16.7	13.7	112.3	25.2	39.7	40.8	50.8
All-P	93.3	18.7	15.7	118.7	25.6	51.2	23.7	63.9
All-K	99.0	20.7	17.7	140.0	26.0	64.0	4.6	80.8
All-S	96.4	20.3	18.0	129.0	25.9	61.0	9.1	76.5
All-Ca	99.5	21.0	18.0	137.0	25.9	65.0	3.1	83.0
All-Mg	98.4	20.3	18.0	136.7	25.9	63.5	5.4	80.9
All-Cu	99.4	20.7	18.3	138.0	25.9	65.4	2.5	81.0
All-Zn	98.1	20.7	18.0	136.0	25.9	63.2	5.8	78.4
All-B	97.6	20.7	17.3	138.3	25.9	62.8	6.4	77.5
All-Mo	97.5	20.7	17.3	141.3	25.9	62.4	7.0	79.6
SEm (±)	**1.02**	**0.65**	**0.80**	**5.77**	**0.24**	**2.40**	-	**3.02**
CD at 5% level	**3.03**	**1.94**	**2.39**	**17.13**	**NS**	**7.13**	-	**8.97**

Table.3 Effect of nutrient omission on total uptake of nutrients by rice (MTU-1001) in *Inceptisol* of *Kondagaon* district of *Chhattisgarh*

Treatments	Primary Nutrients(g pot^{-1})			Secondary Nutrients(g pot^{-1})			Micronutrients(mg pot^{-1})				
	N	**P**	**K**	**Ca**	**Mg**	**S**	**Fe**	**Mn**	**Zn**	**Cu**	**B**
All	1.12	0.26	1.37	0.69	0.40	0.18	21.4	30.7	4.3	0.90	1.20
All - N	0.65	0.15	0.83	0.41	0.23	0.10	12.6	17.8	2.6	0.53	0.73
All - P	0.85	0.17	1.05	0.52	0.30	0.13	16.3	23.0	3.3	0.68	0.93
All - K	1.07	0.24	1.27	0.66	0.37	0.17	20.5	29.0	4.0	0.86	1.17
All - S	1.02	0.23	1.26	0.62	0.36	0.17	19.7	26.5	3.9	0.83	1.11
All - Ca	1.09	0.25	1.37	0.63	0.38	0.18	21.1	29.5	4.1	0.87	1.18
All - Mg	1.06	0.24	1.33	0.66	0.36	0.17	20.6	29.1	4.1	0.86	1.15
All - Cu	1.08	0.24	1.35	0.66	0.37	0.17	20.8	29.6	4.1	0.87	1.18
All - Zn	1.04	0.24	1.31	0.65	0.36	0.17	20.4	27.8	4.0	0.85	1.14
All - Bo	1.04	0.23	1.28	0.63	0.36	0.17	20.7	27.4	3.8	0.84	1.13
All - Mo	1.04	0.23	1.31	0.64	0.37	0.17	20.2	28.6	3.9	0.85	1.14
SEm±	**0.045**	**0.012**	**0.056**	**0.029**	**0.016**	**0.004**	**1.00**	**1.54**	**0.22**	**0.04**	**0.04**
CD at 5% level	**21.4**	**30.7**	**4.3**	**0.90**	**1.20**	**21.4**	**2.95**	**4.53**	**0.64**	**0.11**	**0.13**

Table.4 Grain yield and economics of wheat in relation to SSNM and Farmer's fertilizer dose in *Inceptisol* of *Kondagaon* district

S. No.	Nutrient Dose	Yield (q ha^{-1})	Cost of cultivation (Rs. ha^{-1})	Gross return (Rs. ha^{-1})	Net return (Rs. ha^{-1})	B:C ratio (Rs. Re^{-1})
1	SSNM	28.4	32214	56800	24586	1.76
2	FFD	24.1	27869	48200	20331	1.73
Difference		4.3	4345	8600	4255	0.03
% Change		17.8	15.6	17.8	20.9	1.9

Secondary Nutrients uptake

Calcium uptake

The highest Ca uptake (0.69g pot^{-1}) by rice crop was observed in treatment that received all the nutrients. Omission of N and P nutrients significantly reduced the Ca uptake in comparison to the maximum, and the least uptake was observed in N omission (0.41g pot^{-1}) followed by P omission (0.52 g pot^{-1}) pots. Omission of N and P reduced the uptakes more than that of omission of other nutrients indicating that these two nutrients were the most limiting nutrients. Lower Ca uptakes were observed with N and P omission obviously due to lower grain and straw yields and lower Ca concentrations. Uptakes of Ca in N and P omitted pots were in the order of N < P in accordance with the grain and straw yields and Ca concentrations in the respective pots.

Magnesium uptake

The highest total uptake of Mg was observed with the treatment receiving all the nutrients (0.40 g pot^{-1}) because supply of all the nutrients including Mg in All treatments increased the grain and straw yields as well as the Mg concentrations causing more uptakes of Mg. Whereas, the least Mg uptakes (0.23 and 0.30 g pot^{-1}) was observed with N and P omission since these elements were the most yield limiting in the soil. Mg uptakes were found almost similar in all the other treatments in comparison to all nutrients which might be due to higher initial Mg content in soil. Uptakes of Mg in N and P omitted pots were in the order of N < P in accordance with the grain and straw yields and Mg concentrations in the respective pots.

Sulphur uptake

The highest S uptake (0.18 g pot^{-1}) was recorded in treatment which received all nutrients and the least total uptake of S was observed in the treatment that omit N nutrient. Omission of N and P caused significantly reduced uptake of S, in comparison to treatment that received all the nutrients.

Micronutrients uptake by rice

Fe uptake

The highest Fe uptake (21.4 mg pot^{-1}) was associated with the treatment receiving all the nutrients, closely followed by omission of Ca, Cu, B, Mg, K, Zn, Mo, and S respectively and were statistically at par with each other and significantly higher than Fe uptake in N and P omission treatments. The lowest Fe uptake (12.6 mg pot^{-1}) was recorded in N omission treatment followed by P (16.3 mg pot^{-1}) omission treatment.

Mn uptake

The significant reduction in uptake of Mn was observed in N and P omission treatments than the uptake observed with treatment receiving all nutrients. The total uptake of Mn was found maximum (30.7mg pot^{-1}) in the treatment where all the nutrients was applied which was statistically at par with other treatments except N and P. The least Mn uptake (17.8 mg pot^{-1}) was recorded in the treatment where N was omitted followed by P (13.0 mg pot^{-1}) omission treatment.

Zinc uptake

Total uptake of Zn (4.3 mg pot^{-1}) by rice was found maximum in the treatment receiving all the nutrients and minimum (2.6 mg pot^{-1}) in the treatment where N was omitted. Significantly reduced Zn uptake was observed with omission of N and P as compared to treatment receiving all the nutrients and uptake in other treatments was found at par with it.

Cu uptake

The significant reduction in uptake of Cu (0.53 mg pot^{-1}) was found in N omission pot followed by P (0.68 mg pot^{-1}) omission and both were significantly lower than the Cu uptake (0.90 mg pot^{-1}) observed with the treatment receiving all the nutrients which recorded maximum uptake and statistically at par with Cu uptake in K, S, Ca, Mg, Cu, Zn, B and Mo omitted pots.

B uptake

Omission of N and P nutrients caused significant reduction in the total B uptake by rice over treatment receiving all nutrients (Table 3). It was found maximum (1.20 mg pot^{-1}) in the treatment where all the nutrients were applied and minimum (0.73 mg pot^{-1}) in the where N was omitted followed by uptake of B in P (0.93 mg pot^{-1}) omission treatment. Mo, Cu, K, S, Mg, Ca and Zn omitted pots were statistically at par with each other and that with the treatment receiving all the nutrients.

Field verification of identified yield limiting nutrients

Based on the response of rice crop to nutrients omission, the yield limiting nutrients identified was N and P. They were verified in a verification trial at farmers field, from where the bulk soil was collected for pot experiment, through applying optimum/SSNM dose of these nutrients in wheat during *rabi* season 2017-18. The final grain yields of wheat at farmer's fields under both the doses were recorded and the comparison is presented in Table 4. The wheat grain yields at farmer's fields was higher in SSNM dose applied, based on yield limiting nutrients, as compared to that of farmer's practice dose. The economic analysis of both the fertilizer doses revealed that the SSNM dose had higher gross return, net return and B: C ratio as compared to farmers practice dose, thus, it confirmed that N and P was the yield limiting nutrients and the SSNM dose was economically profitable to the farmers.

References

Ahmed, S., Elahi, N., Khan, R., Faridullah, J. and Din, N. 2010. Wheat response to phosphorus under climatic conditions of Juglote, Pakistan. Sarhad J. Agri., 26: 229–33.

Din, J., Rashid, A. and Zahid, M.A. 2001. Optimizing productivity and profitability in rain fed legume crops through balanced nutrient management. Pakistan J. Soil Sci., 20 (4): 70-74.

Havlin, J.L., Tisdale, S.L., Beaton, J.D. and Nelson, W.L. 2007. Soil fertility and fertilizers – an introduction to nutrient management. Dorling Kindersley Pvt. Ltd., New Delhi, India. 175.

Mc-Beath, T., MMc-Laughlin, M.J., Armstrong, B.R.D., Bell, M., Bolland, M.D.A. Conyers, M.K., Holloway, R.E. and Mason, S.D. 2007. Predicting the response of wheat (*Triticum aestivum* L.) to liquid and granular phosphorus fertilisers in Australian soils. Australian J. Soil Res., 45: 448– 458.

Mishra, V. N., Patil, S. K., Das, R. O. Shrivastava, L. K., Samadhiya, V. K. and Sengar, S. S. 2007. Site-specific nutrient management for maximum yield of rice in *Vertisol* and *Inceptisols* of *Chhattisgarh*. A paper presented in South Asian Conference on "Water in Agriculture: management options for increasing crop productivity per drop of water", during November 15-17, 2007 held at IGKV, Raipur (C.G.), India. pp. 136.

Ray, P.K., Jana, A.K., Maitra, D.N., Saha, M.N., Chaudhary, J., Saha, S. and Saha, A.R. 2000. Fertilizer prescriptions on soil test basis for Jute, Rice and Wheat in a Typic Ustochrept. J. of the Indian Society of Soil Sci. 48(1): 79- 84.

Sahu, N., Mishra, V.N., Srivastava, L.K. and Jatav, G. 2017. Crop Response based Assessment of Limiting Nutrients using Site Specific Nutrient Management for Yield Maximization in Vertisols of Bemetara District of Chhattisgarh, India. Int. J. Curr. Microbiol. App. Sci., 6(6): 1784-1791.

Sakal, R. 2001. Efficient management of micronutrients for sustainable crop production. J. of the Indian Society of Soil Sci. 49(4): 593-608.

Sekhon, G.S. and Velayutham, M. 2002. Soil Fertility Evaluation. In: Fundamentals of Soil Science. Indian Society of Soil Science, New Delhi, 419-432.

Sharma, P.K., Yadav, G.L. and Kumar, S. 2000. Response of wheat to nitrogen and zinc fertilization. Indian J. Agro., 45(1): 124–127.

Singh, R. 2008. Effect of nitrogen management through organic and inorganic sources in sole and intercropped Bt cotton–wheat system. Ph.D. Thesis, Division of Agronomy, Indian Agri. Res. Institute, New Delhi, India. p. 99.

Syed, T.H., Ganai, M.R., Tahir Ali and Mir, A.H. 2006. Effect of nitrogen and sulphur fertilization on yield of and nutrient uptake by sunflower. J. Indian Soc. Soil Sci., 54(3): 375-376.

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